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MARSHALL STAR

In This Week's Star ⊟ (Click to Expand)

Lightfoot: 'It's Our Job to Continue the Journey'
By Rick Smith

On Aug. 1, a day before addressing Huntsville-area business partners and elected officials at his annual community breakfast, Marshall Space Flight Center Director Robert Lightfoot held a work force all-hands to update the Marshall team on what's ahead for the center and to encourage them "to continue the journey."

Image right: Marshall Center Director Robert Lightfoot addresses the workforce during an all hands meeting Aug. 1. (NASA/MSFC)

Lightfoot briefly talked about the debt-ceiling debate in Washington and said that Marshall Center is continuing its work as normal. He also said the shuttle program is ending, Constellation is formally canceled and that "It will be a smaller set of folks needed to do the Space Launch System (SLS) than to do shuttle and Constellation."

The good news, he said, is Marshall will undergo its official reorganization Oct. 1, as approved by NASA Headquarters -- so center leadership is working hard to place as many employees as possible in the new organizational structure. Marshall will use the Work Force Transition Tool to post available positions by Oct. 1, he said. (For more information about the center's new organization, see the top story in the May 26 issue of The Marshall Star.)

Lightfoot praised the hard work of the Marshall team during the past year, noting it was a challenge to cull the past year's roster of accomplishments down to a manageable list to share with attendees at the Aug. 2 breakfast. "Every two weeks, if you average it out, we did something pretty cool," he said. "It's amazing to look back and see what we've done. You should be proud."

He acknowledged that Marshall and NASA now stand at a crossroads, but he maintains a positive outlook on the future. He shared a quote: "Changes in our organizations and projects have seemed to come about every five years," he read. "While there were periods of famine as far as projects, money and personnel go … we have struggled for a certain degree of stability."

"Sound familiar?" he asked. It was from a speech given at a research management conference in 1962 by Dr. Wernher von Braun, as NASA strove to put the first man on the moon by decade's end.

Lightfoot emphasized the exciting challenges ahead of NASA, and all the science and exploration work still to be done. He recalled the post-Apollo era at NASA, when the agency began the transition from its lunar missions to development of the space shuttle and some critics -- and employees -- suggested Marshall's work was done.

"Look what we've done since," he said, ticking off the successes of the International Space Station, Spacelab, the Hubble Space Telescope, the Chandra X-ray Observatory and the shuttle program itself -- which concluded 30 years of flight in July when the crew of space shuttle Atlantis returned to Earth for the final time.

"Think about all the teams that came before you, and what they left you," he said. "It's our job to continue the journey."

Lightfoot encouraged team members to ask questions via email and ExplorNet, and promised to share further updates as the center prepares for reorganization.

Some 250 community representatives attended the Center Director's Breakfast Aug. 2 at the U.S. Space & Rocket Center in Huntsville. During the event, Lightfoot presented the annual Marshall Center Contractor Excellence Awards, which honor prime contractors, subcontractors and suppliers who have made significant, sustained contributions to NASA's and Marshall's mission during the preceding three to five years.

Teledyne Brown Engineering and Alliant Techsystems (ATK) Space Launch Systems, both of Huntsville, received the "Large Business -- Service" award and the "Large Business -- Product" award, respectively. Teledyne Brown contributes a variety of services to the Marshall Center, and in 2010, notably delivered integrated structure and avionics systems for NASA's Robotic Lander Development Project, now undergoing testing at Marshall to enable robust, automated space exploration missions across the solar system. ATK provided the space shuttle's reusable solid rocket motors and booster separation motors, and is responsible for the launch abort system motor for the Orion crew capsule, successfully demonstrated in 2010 during NASA's Pad Abort-1 flight test.

Smith, an AI Signal Research Inc. employee, supports the Office of Strategic Analysis & Communications.

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Space Shuttle Program: Spanning 30 Years of Discovery

Compiled by Sanda Martel

NASA's shuttle fleet achieved numerous firsts and opened up space to more people than ever before during the Space Shuttle Program's 30 years of missions.

Image left: On July 21, Marshall team members celebrate the successful landing of STS-135, the final space shuttle mission, in Morris Auditorium during the Shuttle Pride Social hosted by the Marshall Exchange. (NASA/MSFC)

The space shuttle, officially called the Space Transportation System, began its flight career with Columbia roaring off Launch Pad 39A at Kennedy Space Center, April 12, 1981.

That first mission verified the combined performance of the orbiter, its twin solid rocket boosters, giant external fuel tank and three space shuttle main engines. It also put to the test the teams that manufactured, processed, launched and managed the unique vehicle system, which consists of about two-and-one-half million moving parts.

The orbiter, with three space shuttle main engines clustered in the aft end, was the only part of the shuttle stack that made the trek into orbit. Its boosters were jettisoned into the Atlantic Ocean, retrieved and reused. The external tank was the only part of the stack not used again. Instead, it reentered the atmosphere about nine minutes after launch and burned up over the Pacific Ocean. When the shuttle returned to Earth, it glided back on a pair of wings to a runway.

As the world's first reusable spacecraft that carried humans into orbit, the shuttle's 60-foot-long payload bay and robotic arm could carry several satellites into low-Earth orbit on one flight, service them and bring them back for future use. The shuttle fleet, designed to reach orbits ranging from about 115 to 400 miles high, also routinely carried whole laboratories into orbit for unique experiments. It also was called on to build the International Space Station, the largest spacecraft ever, which was assembled in orbit.

When President Nixon launched the Space Shuttle Program on Jan. 5, 1972, the task set before NASA may have seemed basic compared with the accomplishments of the Apollo Program, which landed humans on the moon and safely returned them to Earth. The reality was the Space Shuttle Program was tackling unprecedented challenges in designing the first winged, reusable spacecraft capable of carrying more payload and crew than anything ever before imagined.

NASA and Contractors Come Together to Make History

In the summer of 1971, NASA selected the Rocketdyne Division of Rockwell, now Pratt & Whitney Rocketdyne, of East Hartford, Conn., to begin construction of the space shuttle main engines. Rocketdyne had built the large, liquid fuel rocket engines used on NASA's Saturn V. Three of these engines were mounted on the orbiter's aft fuselage in a triangular pattern.

Space shuttle external tanks were built at NASA's Michoud Assembly Facility. In September 1973, NASA announced that it had signed a contract with Martin Marietta Corporation for the design, development and testing of the external fuel tank. The first tank was assembled in 1976, and the following year fabrications for the first flight tank began. The first flight tank was delivered to Kennedy Space Center in July 1979, and would fly two years later as part of shuttle Columbia and STS-1. In 1995, Martin Marietta merged with Lockheed Corporation, forming Lockheed Martin of Bethesda, Md.

In 1974, Thiokol Corp., now Alliant Techsystems of Minneapolis, Minn., was chosen to design and build the solid rocket motors used to lift the space shuttle from the launch pad to the edges of Earth's atmosphere. The space shuttle solid rocket boosters were the largest solid propellant motors ever built and the first to be used on a manned spacecraft. The motors were manufactured at ATK facilities in Utah and shipped via rail to Kennedy, offloaded and inspected, transported to the Vehicle Assembly Building and eventually mated with the external tank and orbiter. During shuttle launches, boosters burned for two minutes in conjunction with the main engines during initial ascent and gave the added thrust needed to achieve orbital altitude. After two minutes of flight, at an altitude of about 24 miles, the boosters would separate from the external tank and descend by parachute into the Atlantic Ocean. They were recovered by ship, returned to ATK's Utah facility and refurbished for reuse.

All space shuttle orbiters were built by Rockwell International of Palmdale, Calif. Approximately 250 major subcontractors supplied various systems and components to the Palmdale facility where individual parts, pieces and systems were assembled and tested.

Enterprise was the first space shuttle, although it never flew in space. The Marshall Space Flight Center's Dynamic Test Stand was the site where vibration testing on shuttle Enterprise in a launch configuration was conducted in March 1978. The vibration tests marked the first time all shuttle components -- the orbiter, external fuel tank and solid rocket boosters -- were attached. Testing continued until March of the next year.

Columbia was the first shuttle to fly into orbit on STS-1. Its first four missions were test flights to show that the shuttle design was sound. Astronauts operated the robotic arm and put all the flight systems through evaluation phases during the test flights. Shuttle Columbia and its seven astronauts were lost Feb. 1, 2003, when Columbia broke apart during re-entry on its 28th mission, STS-107.

Challenger was the second operational shuttle and made its first flight, STS-6, which launched April 4, 1983. Challenger hosted missions that saw astronauts take the first-ever spacewalks with jetpacks, including the first mission to pull a satellite out of orbit, fix it and return it to service. Challenger and its seven astronauts were lost Jan. 28, 1986, 73 seconds after launch.

Discovery was the third operational shuttle and made its first flight, STS-41D, in August 1984. Discovery flew more missions than any other shuttle: 39. It was the first space shuttle retired from the fleet, following its STS-133 mission in February and March 2011.

Endeavour, the last space shuttle built, was ordered to replace Challenger. Endeavour was the second shuttle to be retired, after it successfully flew the STS-134 mission to deliver the Alpha Magnetic Spectometer to the International Space Station in May and June 2011.

Atlantis was the fourth operational shuttle and made its first flight on STS-51J, launched Oct. 3, 1985. Atlantis flew the final space shuttle mission, STS-135, in July 2011.

Shuttle Costs

For Fiscal Year 2010, the average cost to prepare and launch a shuttle mission was approximately $775 million. Shuttle Endeavour cost approximately $1.7 billion to build. The life of the shuttle program has cost $113.7 billion, not adjusted for inflation.

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Director's Corner: It Takes a Team

Congratulations to the entire Space Shuttle team -- propulsion, payloads, and everyone who supported the program for finishing the program strong.


Robert Lightfoot, Marshall Center Director (NASA/MSFC)

It was an incredible program. Out of all its many capabilities and its many accomplishments, which one was most important? Which one stands out most? The reusable orbiter? The launch and servicing of the Hubble Space Telescope? Construction of the International Space Station? There are lots of choices.

As I stood on the runway at Kennedy Space Center for the STS-135 landing recently, I realized what I'd choose. It was the Shuttle team.

That team didn't exist 30 years ago. But it grew over time. At the end of the program, what we find ourselves talking about is the people and the team, not the vehicle. In the end, the success of the Shuttle was a byproduct of the outstanding team. History will say the Shuttle was powered by hydrogen, oxygen, and solid propellant. I would say it was powered by teamwork.

We've spent the past two years having rocket discussions: which engine, which fuel, which stage diameter? Engineers love those discussions, but we can build anything and make it work. We will fail, though, if we don't work as a team. Internally, we have to bring together the operations mindset of the Shuttle team and the development mindset of the Ares team. Externally, we have to get the community and stakeholders together for a common goal.

With the Shuttles formally retired, it's time to form a new team. It's time to move on and get behind the SLS team and make it a success. It won't be easy. We continue to get challenges with budgets, and there will soon be hardware challenges. But overcoming those challenges is what we do. It's where we shine.

If we focus on the same mission, the vehicle will show up. I'm asking everyone to recommit continuing the journey of space exploration the only way we've ever succeeded -- together.

Robert Lightfoot
Marshall Center Director

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Shuttle Organization at Marshall Dates Back to 1969
By Sanda Martel

As the Apollo program began winding down in the late 1960s, NASA began looking ahead to the next step beyond lunar exploration. A crewed space station and alternatives to expendable rockets were considered and the concept of a reusable space shuttle was particularly appealing as a vehicle to ferry people and supplies to and from orbit.

A Marshall Space Flight Center organization chart dated September 1969 shows the Space Shuttle Task Team headed by William. A. Mrazek. During this period, teams at both Marshall and Johnson Space Center were defining general characteristics of the shuttle. Findings of two design studies determined the spacecraft would be a two-stage, fully reusable craft capable of performing for 100 missions; it would feature high-performance hydrogen/oxygen engines with throttle capability to power the vehicle; it would take off vertically and land horizontally; and the orbiter's cargo bay was to be 60 feet long and 15 feet in diameter. Many other questions about how the shuttle would be built and how it would operate remained and would be answered before the first shuttle lifted off on its first mission in 1981.

In December 1970, Roy Godfrey is listed as the Space Shuttle Task Team manager. By August 1972, the organization's name had been changed to Shuttle Projects Office.

Following Godfrey's tenure, Robert Lindstrom headed the office for about 10 years beginning in May 1975, according to information on the organization chart. He was succeeded by S.R. Reinartz, beginning in February 1985. Robert Marshall is first listed as manager of the Shuttle Projects Office in April 1986 and his name remains on the organization chart until Porter Bridwell's first appears in July 1989. Bridwell served in the position several months in 1989, until he was appointed director of the Marshall Center in January 1994, a position he held until February 1996.

Alex McCool was the longest-serving manager of Shuttle Projects Office -- from May 1992 to May 2003. In April 2003, the organization's name was changed to Space Shuttle Propulsion Office.

Michael Rudolphi was appointed manager of the office in December 2003, serving until November 2005, followed by Robert Lightfoot, until he was named deputy director of the Marshall Center in 2007.

The current manager, Steve Cash, was appointed in August 2007.

Marshall's Space Shuttle Propulsion managers oversaw the manufacture, assembly and operation of space shuttle propulsion elements -- the external tank, space shuttle main engine and reusable solid rocket booster. The manager has two lines of responsibility -- to the Shuttle Program Office at Johnson Space Center and to the Marshall Center director.

Martel, an AI Signal Research Inc. employee, supports the Office of Strategic Analysis and Communications.

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Dr. Jan Davis: Marshall's First Astronaut

By Sanda Martel

Three-time shuttle astronaut Dr. Jan Davis was captivated by the space program at an early age -- when Mercury astronaut Alan B. Shepard piloted his Freedom 7 capsule atop a Mercury-Redstone rocket in 1961 to become the first American to fly in space.

Image left: Davis, inside the Spacelab module near her Auburn pennant, during her first trip to space on the STS-47 mission in 1992. (NASA)

Growing up in Huntsville -- surrounded by the work that led to the Apollo program -- Davis remembers hearing the roar of the mighty Saturn engines when they were tested at the Marshall Space Flight Center in the 1960s.

"I can remember how neat it was when the engines were tested and the whole city shook," said Davis. As a high school student, she traveled to Cape Canaveral, Fla., in July 1969 to witness those mighty Saturn engines start up on the launch pad to launch the Apollo 11 mission -- which landed Americans on the moon for the first time. At that moment, she was hooked.

Davis graduated from Huntsville High School in 1971, and received a bachelor's degree in biomechanics from Georgia Institute of Technology in Atlanta in 1975. "I wanted to work in the space program, but at that time there weren't many opportunities to work at NASA," Davis said. After receiving a bachelor's in mechanical engineering from Auburn University in 1977, Davis accepted a job as a petroleum engineer with Texaco Inc., in Bellaire, Texas. She began her NASA career in

1979 as an aerospace engineer at the Marshall Center, where she worked on several major programs and projects, including the Hubble Space Telescope, a Hubble servicing mission, the Chandra X-ray Observatory and served as lead engineer for the solid rocket booster external tank attach ring redesign. While working at Marshall, Davis received a master's and doctorate in mechanical engineering from University of Alabama in Huntsville in 1983 and 1985, respectively.

Thinking that being an astronaut would be "the ultimate job as a NASA employee," Davis applied with the Astronaut Corps in March 1984, along with more than 5,000 applicants, and was one of only 128 interviewed. Although not selected, she was not deterred and reapplied in 1985 and again in 1987.

"Growing up, I didn't think it possible that I would ever fly into space because I was female and not a military test pilot," Davis said. But beginning in 1978, and again in 1980, women and nonmilitary astronauts were accepted into the program.

In 1987, Davis got the call, along with 14 others, to join the Astronaut Corps. Davis flew as a mission specialist on STS-47 in September 1992 and STS-60 in February 1994, and served as payload commander on STS-85 in August 1997. During her three space shuttle flights, she logged more than 673 hours in space.

> **"My most memorable moment in space was during my last mission, in August 1997, flying over Huntsville. I had never seen Huntsville from space, and it was a beautiful, clear day. I thought of my family and friends and the many people in the Huntsville area who helped make it possible for Americans to fly in space. The citizens of Huntsville were so happy and supportive of my selection as an astronaut and followed my career. At that moment I felt a great sense of gratitude." --Dr. Jan Davis**

"Training was intense in terms of the amount of time devoted and the amount of information we had to learn. However, it was fun because I really like to learn and the people I worked with were great. The instructors, the crew and the mission controllers were like a family. We also had specialists come in and teach us things like astronomy, meteorology, orbital mechanics, medical procedures, photography, speech making and we had a geology field trip to New Mexico."

"All of my missions were international and scientific ones and I was so impressed by the dedication and capability of people around the world who love the space program. It was really interesting to train in those countries and to learn about their cultures. It takes thousands of people to make it possible for a few astronauts to safely fly. I really enjoyed helping scientists collect data and perform experiments, to make their lifelong dreams and visions possible."

Davis returned to Marshall in July 1999 as director of the Flight Projects Directorate, after serving for two years in a NASA Headquarters position. In August 2003, she was named director of Marshall's Safety and Mission Assurance Directorate. She retired from NASA in 2005 and is vice president and deputy general manager at Jacobs Engineering, Science and Technical Services Group, in Huntsville, providing engineering, scientific and project management support for Marshall projects and programs.

She also continues speaking to students whenever she can about her space experiences and her perseverance to become an astronaut. "I know how important it is to be a role model so that young people can understand that anything is possible. You don't have to be limited by gender or ethnicity," added Davis.

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Shuttle Saw Many Improvements Over the Years

By Mike Wright and Jim Owen

Reprinted from the April 14, 2011 Marshall Star

For more than 30 years, improvements in the Marshall Space Flight Center's space shuttle propulsion system -- the external tank, solid rocket boosters and solid rocket motors and the space shuttle main engine -- made the shuttle safer and better.

Each element underwent upgrades that improved performance, reliability and safety in a relentless pursuit of improvement. For the full article, click here.

Link to full article

Wright is the Marshall Center historian. Owen is chief engineer of the Shuttle Propulsion Office.

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A Conversation with Marshall's Dr. Fred Leslie, STS-73 Payload Specialist

By Sanda Martel

The Marshall Star recently spoke with Dr. Fred Leslie, a former astronaut who flew on the STS-73 mission in 1995 as a payload specialist. Leslie is now an aerospace engineer in the Natural Environments Branch of Marshall Space Flight Center's Engineering Directorate, providing global atmospheric values and turbulence data to designers of aerospace vehicles in government, academic, private and defense organizations.

Image right: Leslie conducts research in shuttle Columbia's cargo bay during the STS-73 mission in 1995. (NASA)

Leslie talked about his experience of slipping the surly bonds of Earth to become one of the few humans to fly in space. He also discussed his background and path to becoming an astronaut, reflected on the shuttle and other spaceflight programs and took a look forward to what the future might hold.

Leslie began his NASA career in 1980 as a research scientist in the Marshall Center's Space Science Laboratory. He served as chief of the Fluid Dynamics Branch, beginning in 1987, directing and conducting research in both laboratory and theoretical investigations.

He was co-investigator for the Geophysical Fluid Flow Cell experiment that flew on STS-51-B in 1985. In 1992 he served in the Spacelab Mission Operations Control Center as the mission scientist for STS-47, coordinating more than 40 domestic and Japanese experiments in fluid dynamics, crystal growth and life science during the eight day mission.

Leslie became deputy chief of the Earth System Science Division in 1994, before his selection as a payload specialist. He flew aboard space shuttle Columbia on the STS-73 mission, which launched Oct. 20, 1995, landing Nov. 5. The mission marked the second flight of the U.S. Microgravity Laboratory, directed by NASA's Spacelab Mission Operations Control facility at the Marshall Center.

Leslie logged 382 hours during his only trip to space. The 16-day Spacelab mission focused on materials science, biotechnology, combustion science and fluid physics research within the pressurized Spacelab module -- a multi-configuration, space-borne scientific laboratory designed to fit inside the payload bay of the orbiter.

He earned a bachelor's in engineering science from the University of Texas at Austin, a master's and doctorate in meteorology from the University of Oklahoma in Norman in 1977 and 1979, respectively, and continued with post-doctoral studies at Purdue University in West Lafayette, Ind., in 1979. He came to the Marshall Center in 1980 as a visiting scientist while working for the Universities Space Research Association, a private, nonprofit corporation under the auspices of the National Academy of Sciences.

Leslie has authored numerous journal and conference papers, as well as NASA reports involving atmospheric and fluid dynamic phenomena.

What inspired you to become an astronaut?

Shortly after I came to work at Marshall in 1980, I watched the first shuttle launch, STS-1, on television. I can still remember the landing, when Commander John Young practically jogged down the exit stairs pumping his fist with excitement about the new vehicle -- space shuttle Columbia -- and its potential. I had no idea that I would fly aboard that same vehicle almost 15 years later. One of my assignments at Marshall involved a geophysical fluid flow experiment being developed for the Spacelab Program. The instrument was eventually manifested to fly on the Spacelab 3 mission, STS-51-B, in 1985, and my duties included training the payload crew on its operation. It was during this time that I realized I could perform those activities myself should the experiment ever fly again. I believed this because I not only had the scientific background, but also a variety of operational experiences. As a pilot, I was accustomed to following checklists; I was a skydiver and comfortable working in a potentially hazardous environment; and a scuba diver in Marshall's Neutral Buoyancy Lab, where I was exposed to additional crew training. I also was familiar with NASA phraseology and procedures. I was doing these things because I enjoyed them, not because I was trying to build an astronaut resume. So when the experiment was manifested for re-flight on STS-73, I applied to be a payload specialist, was accepted and flew the mission. It was an incredible experience that I will never forget.

Can you describe the experience?

There are so many that it's tough to provide a comprehensive list that's also brief. Clearly, getting to T-0 on launch day is unique. I had been to the vehicle a number of times while it was on the launch pad. A lot of activity was always taking place there -- technicians performing tests and inspections and stowing flight items; service vehicles flowing in and out of the pad area; security personnel, safety people, and quality control specialists all performing their duties. But on the morning of the launch, I was struck by the absence of the normal pad population. There was only our flight crew and a few folks to strap us in. It was more solemn and quiet than before, except for a sound I hadn't heard before: the constant hiss of gases venting from a fully loaded fuel tank. Once strapped in, my only hope was that we would launch. My mission had tied the record for the number of scrubbed launches -- six -- and two of those occurred after the crew had ingressed the vehicle. Another scrub would mean we would have to wait for almost an hour before the closeout crew could return to the pad, take the elevator to the 195-foot-level, open the hatch, and unstrap us. On the other hand, if we launched, we'd be in orbit in only eight-and-a-half minutes and be out of the seats shortly thereafter.

What was your most memorable moment?

The view of the Earth leaves quite an impression. I had heard from the space veterans how spectacular it was. So not long after main engine cut-off and the orbital maneuvering system burn, I gradually sneaked over to the windows on the flight deck for a quick look. It's breathtaking and photos just don't capture what the eye sees anymore than a photo of the Grand Canyon generates the same sensation as standing near its edge. Several features are immediate: the brightness of the Earth on the sunlit side, the three-dimensional depth of the Himalayas, the vascular appearance of large rivers, the numerous thunderstorms on the dark side, the dull yellowish hue of cities at night, and everything always in motion as the orbiter moves over the Earth at five miles per second.

What advice would you give to young people who aspire to be part of the nation's space program?

Although there are a variety of skills needed to contribute to the space program, NASA is foremost a science and engineering organization, sharing a foundation in mathematics. Nurturing those capabilities provides a marketable skill set desirable in a world that relies more heavily on technology. Regarding those with a desire to be astronauts, I believe the path to space has always been evolving. The original seven astronauts were military test pilots -- a quite elite group. The Apollo era saw some of the first scientist astronauts, including a geologist who walked on the moon. During the shuttle program, the Astronaut Corps had a significant number of scientists and engineers in a variety of disciplines. Elementary school teachers were soon admitted and Russia began selling seats aboard its capsules to entrepreneurs who had a significant amount of disposable income. More recently, we've seen a private company launch suborbital rockets with its own corporate astronauts at the controls. So there may be a number of ways to get there. But keep in mind that a goal without a plan is just a dream.

Other comments and observations from Fred Leslie:

The first 20 years of America's spaceflight program were truly amazing when you consider all that took place between 1961, when Alan Shepard first flew the Freedom 7 Mercury capsule, and 1981 when Columbia launched. During that period we also had the Gemini Program, Apollo with six moon landings, the first international mission with Apollo-Soyuz and Skylab -- the first space station -- and of course the first space shuttle launch. This reflection also prompts us to look forward. The uncertainty that currently exists will eventually get sorted out, we'll move forward and once again leave low-Earth orbit. Many of us hope that the rocket technology has not reached a plateau, and we'll go beyond chemical propulsion at least for the enroute phase. But NASA is not just about human exploration and developing that technology. If we cannot immediately go to the planets ourselves, maybe we can bring them here with robotic sample return missions. The next generation space telescopes will see much beyond the reach of robotic spacecraft. There is certainly a long list of worthwhile endeavors to keep us occupied and I'm intrigued by a quote I once heard: namely, that somewhere out there, something wonderful is waiting to be discovered.

To read Leslie's bio, visit http://www.jsc.nasa.gov/Bios/PS/leslie.html.

Martel, an AI Signal Research Inc. employee, supports the Office of Strategic Analysis and Communications.

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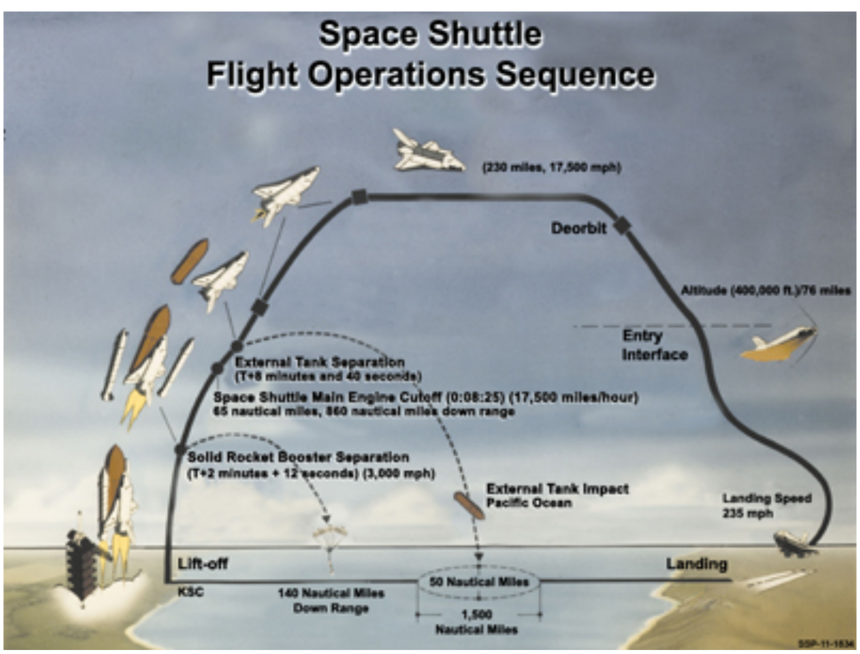
Milestone Missions

By Sanda Martel



Since STS-1 launched April 12, 1981, 355 individuals from 16 countries flew 852 times aboard the space shuttle. The five shuttles -- Columbia, Challenger, Discovery, Endeavour and Atlantis -- traveled more than 542 million miles and hosted more than 2,000 experiments in the fields of Earth, astronomy, biological and materials sciences.

Image left: Shuttle launch sequence (NASA)

The shuttles docked with two space stations, the Russian Mir and the International Space Station. Shuttles deployed 180 payloads, including satellites, returned 52 from space and retrieved, repaired and redeployed seven spacecraft.

NASA's space shuttle fleet began setting records with its first launch and continued to set high marks of achievement and endurance until shuttle Atlantis completed the STS-135 mission with landing at the Kennedy Space Center July 21, 2011. Some significant shuttle missions include:

STS-1, April 12, 1981 -- Space shuttle Columbia launched from the Kennedy Space Center on the first shuttle mission. Primary mission objectives were a safe ascent into orbit, check out of all systems on the shuttle and return to Earth for a safe landing. All objectives were successfully met. Landing was April 14 at Edwards Air Force Base, Calif.

STS-5, Nov. 11, 1982 -- Space shuttle Columbia, in the first shuttle operational mission, deployed the first two shuttle-launched commercial communications satellites. Each was equipped with a payload assist module-D solid rocket motor, which fired about 45 minutes after deployment and placed each satellite into a highly elliptical orbit. Landing was Nov. 16 at Edwards.

STS-9, Nov. 28, 1983 -- Space shuttle Columbia flew the first Spacelab mission, known as Spacelab-1, which, along with 22 subsequent Spacelab missions, transformed the shuttle into an orbiting laboratory. The Marshall Space Flight Center provided science mission management teams and ground facilities for science operations on most Spacelab missions. Spacelab was jointly designed, built and financed by 10 European nations through the European Space Agency. STS-9 was the first mission on which an astronaut representing the European Space Agency flew. During Spacelab missions, astronauts conducted investigations to demonstrate the capability for advanced research in space. The orbiting laboratory contained an observation platform composed of cylindrical pressurized modules and U-shaped unpressurized pallets which remained in the orbiter's cargo bay during flight. STS-9 was the first time six people were carried into space on a single vehicle. Launch was from Kennedy and landing was Dec. 8 at Edwards.

STS-31, April 24, 1990 -- Space shuttle Discovery's primary payload, the Hubble Space Telescope, launched from Kennedy and landed at Edwards April 29. One of NASA's four "Great Observatories," along with the Compton Gamma-Ray Observatory, Chandra X-Ray Observatory and Spitzer Space Telescope, only Hubble was serviceable by space shuttle astronauts. All of the Great Observatories have a particular range of light, or electromagnetic radiation, to which they are designed and are sensitive. Hubble's domain extends from the ultraviolet through the visible and to the near-infrared, a key piece of "astronomical real estate" -- a dominant range of wavelengths emitted by stars and galaxies. Hubble takes advantage of this access with both imaging and spectroscopy. Hubble has seen its capabilities grow immensely in its historic years of operation -- the direct result of the installation of new, cutting-edge scientific instruments and more powerful engineering components. Replacement of aging or failed parts has been an important part of servicing and has been responsible for the telescope's longevity. Servicing missions include STS-61 in December 1993; STS-82 in February 1997; STS-103 in December 1999; STS-109 in March 2002; and STS-125 in May 2009. Hubble reached a major milestone, its 20th anniversary in orbit, April 24, 2010. Hubble imagery has continued to delight and amaze people around the world and has rewritten astronomy textbooks with its discoveries.

STS-37, April 5, 1991 -- Space shuttle Atlantis launched from Kennedy with its primary payload, the Compton Gamma Ray Observatory, which was deployed on flight day three. Compton, at 17 tons, was the heaviest astrophysical payload ever flown at the time of its launch. The observatory was designed to study the universe in an invisible, high-energy form of light known as gamma rays. It was safely deorbited and reentered the Earth's atmosphere on June 4, 2000. Shuttle Atlantis landed at Edwards April 11.

STS-71, June 27, 1995 -- Space shuttle Atlantis' mission marked a number of historic firsts in human spaceflight: 100th U.S. human space launch from Kennedy; first U.S. space shuttle-Russian Space Station Mir docking and joint on-orbit operations; largest spacecraft ever in orbit; and first on-orbit change out of shuttle crew. Landing was July 7 at Kennedy.

STS-88, Dec. 4, 1998 -- Space shuttle Endeavour delivered the Unity node to the International Space Station, beginning NASA's and the European Space Agency's many contributions to the largest international cooperative space venture in history. Endeavour's primary mission objective was to rendezvous with the already launched Zarya control module and successfully attach Unity to provide the foundation for future space station components. Landing was Dec. 15 at Kennedy.

STS-93, July 22, 1999 -- Space shuttle Columbia launched from Kennedy on a five-day mission to deploy the Chandra X-ray Observatory. Chandra allows scientists from around the world to obtain X-ray images of exotic environments to help understand the structure and evolution of the universe. The Chandra X-ray Observatory program is managed by Marshall for the Science Mission Directorate at NASA Headquarters. Landing was July 27.

Return to Flight Missions: STS-114 in July 2005 and STS-121 in July 2006 -- These missions debuted and tested new equipment and procedures that increased shuttle safety, including external tank designs and processes that minimized potentially damaging debris during launch. Ground and flight camera systems were added to observe the shuttle environment during launch. On-orbit techniques for in-flight inspection and repair of the shuttle's thermal protection system, or heat shield, were tested and a redesign of the solid rocket booster bolt catcher -- located on the top of the boosters where they attached to the external tank -- was flown on STS-114. A Marshall-developed experimental space shuttle wing repair material, dubbed "NOAX" for non-oxide adhesive experiment, was successfully tested on STS-121. Discovery's STS-114 landing was at Edwards Aug. 9 and Discovery's STS-121 landing was July 17 at Kennedy.

STS-135: The Final Mission -- Wrapping up 30 years of unmatched achievements and blazing a trail for the next era of U.S. human spaceflight, NASA's storied Space Shuttle Program came to a "wheels stop" July 21, 2011, when space shuttle Atlantis completed the 135th mission. During the 12-day mission, which launched July 8, 2011, astronauts delivered more than 9,400 pounds of spare parts, spare equipment and other supplies in the Raffaello multi-purpose logistics module, managed by engineers at the Marshall Center. These supplies will sustain space station operations for the next year. The 21-foot-long, 15-foot-diameter Raffaello brought back nearly 5,700 pounds of unneeded materials from the space station. The STS-135 crew consisted of Commander Chris Ferguson, Pilot Doug Hurley, and Mission Specialists Sandra Magnus and Rex Walheim. "This final shuttle flight marks the end of an era, but today, we recommit ourselves to continuing human spaceflight and taking the necessary -- and difficult -- steps to ensure America's leadership in human spaceflight for years to come," said NASA Administrator Charles Bolden.

Martel, an AI Signal Research Inc. employee, supports the Office of Strategic Analysis and Communications.

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Did You Know?
Compiled by Sanda Martel

The space shuttle's original name was Space Transportation System and missions continued to use the "STS" prefix. Each launch was assigned an "STS" number in the order it was planned. Sometimes circumstances with payload development or orbiter processing, for example, caused one mission to be postponed, allowing another mission to move ahead of it in line. Numbers were not changed if missions were delayed or rescheduled.

Missions STS-1 through STS-9 flew in numerical order. After STS-9, in 1983, the sequential numbers assigned to designated missions were changed to a code. Thus, the 10th shuttle mission, in 1984, was STS-41B. In this instance, the first digit represented the fiscal year in which the flight was budgeted to fly -- the "4" stood for 1984. The second digit, "1" represented the launch site -- "1" for the Kennedy Space Center, and "2" for Vandenberg Air Force Base, Calif. The letter indicated the scheduling sequence within the fiscal year -- "A" for the first mission of the fiscal year, "B" and the second, etc. This code continued through the 25th shuttle mission, STS-51L, in 1986. During that period Vandenberg was never used as a launch site but was on the manifest to begin in 1986. However, space shuttles were never launched from Vandenberg.

After STS-51L, mission designation numbers reverted to the original sequential number system. Thus, the 26th shuttle mission was STS-26 and all subsequent missions were numbered in the order they were planned.

For more amazing facts about the space shuttle main engine, click here.
For more amazing facts about the external tank, click here.
For more amazing facts about the reusable solid rocket boosters, check here.

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What Has the Space Shuttle Program Meant to You?

Marshall Space Flight Center team members are invited to submit their thoughts, sentiments and memories of the Space Shuttle Program by answering the question, "What has the shuttle program meant to you?" Please limit responses to one paragraph and submit to sanda.t.martel@nasa.gov.

Your comments will be posted on a Marshall Center Web page, http://www.nasa.gov/centers/marshall/shuttle_station/shuttle_memories.html.

Visit the link to view responses already submitted.

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Marshall Team Member Debbie Allen Wins Autographed STS-135 Shuttle

Marshall Exchange Operations Manager Edwin Jones, left, congratulates Marshall human resources specialist Debbie Allen, right, and her daughter Brandy Allen, center, for winning the 1:100 scale Atlantis full shuttle stack model autographed by the entire crew of STS-135 at the Marshall Exchange Shuttle Pride Social held July 21. (NASA/MSFC)

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Shuttle Office Holds Final Awards Day Event

Steve Cash, manager of the Marshall Space Flight Center's Shuttle Propulsion Office, addresses 300 Marshall team members attending the final Shuttle Awards Event, held July 25 at Activities Building 4316. The annual event was particularly poignant this year due to the conclusion of the 30-year program. But it also was a time to recognize the program's successes and the employees who devoted their efforts to those successes. Employee recognition, fellowship, food and group photographs were the order of the day. "Cash's Carnival," a game in which participants vied for tickets to exchange for various shuttle memorabilia such as pins, posters, patches and pictures, proved very popular with attendees. (NASA/MSFC/Emmett Given)

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Obituary: Einar Tandberg-Hanssen

Marshall Space Flight Center retiree Dr. Einar Andreas Tandberg-Hanssen, 89, of Huntsville passed away July 16. Initially employed at the Marshall Center in 1974 as a senior research scientist, he later served as deputy director and then director of the Space Science Laboratory.

At Marshall, Tandberg-Hanssen built up a substantial, internationally based group of solar physicists. In addition, he served as a principal investigator responsible for instruments aboard the Apollo Telescope Mount in the early 1970s and the Solar Maximum Mission, which made sweeping new studies of the sun in the 1980s. Beginning in 1993, he served part-time as professor of physics at the University of Alabama.

Tandberg-Hanssen earned a doctorate in astrophysics at the University of Oslo in 1960 with a dissertation entitled "An Investigation of the Temperature Conditions in Prominence with a Special Study of the Excitation of Helium." Among numerous other honors and awards, he was a member of the Norwegian Academy of Science and Letters.

Find this article at:

http://www.nasa.gov/centers/marshall/about/star/index.html